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Agriculture and Agricultural Science Procedia 5 (2015) 164 – 169
Agriculture and Agricultural Science Procedia

1st International Conference on Asian Highland Natural Resources Management, AsiaHiLand 2015

Effects of Slaughter Weight on Carcass and Meat Characteristics of Punga Fish (*Pangasius bocourti* Sauvage)

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ABSTRACT

Punga Fish (*Pangasius bocourti* Sauvage) is a type of skin fish from the Pangasiidae family. Pangasius is currently highly demanded in the world market. The objective of this study was to investigate the effects of slaughter weight on carcass and meat quality of Punga fish. Two hundred and forty Punga fish from a commercial farm were divided into three groups, 80 fish for each group, based on average target body weights of 700, 900 and 1200 g, respectively. Meat quality was investigated in two muscle sections, the dorsal and the ventral fillet. Carcass quality (dressing and fillet percentage) did not change with slaughter weight. Fillet pH measured at 45 min and 24 h gradually decreased from 6.68 to 5.98 and 6.66 to 5.97 in dorsal and ventral fillet, respectively. Drip loss was larger in the dorsal fillet of the groups weighing 900 and 1200 g. The highest fat percentage was found in the ventral section of fish group weighing 1200 g. Thiobarbituric acid reactive substances (TBARS) were increased in every group and meat section with storage. It was highest in the ventral section of the group weighing 1200 g. In addition, a greater collagen concentration was found in ventral than in the dorsal fillet. Otherwise, slaughter weight and muscle section did not have significant effects on thawing loss, moisture and protein percentage.

Peer-review under responsibility of the Faculty of Agriculture, Chiang Mai University

Keywords: Punga fish; Weight; Carcass; Meat

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Peer-review under responsibility of the Faculty of Agriculture, Chiang Mai University
doi:10.1016/j.aaspro.2015.08.025

1. Introduction

The globalization of markets has resulted in greater economic integration, but at the same time has imposed the need to satisfy increasing consumer demands for a high meat quality. Therefore, the meat industry and animal producers must comply with certain quality standards to these consumer demands in order to remain competitive. In this context, it is necessary to know the different factors that can affect the main characteristics of meat and carcass quality. Fish is an important and valuable source of protein for humans and. Aquaculture is the fastest growing animal food producing sector in the world. It has had an annual growth rate of 8.9% since 1970, compared with 1.4% for capture fisheries and 2.8% for terrestrial farmed meat production systems over the same period (FAO, 2005). Currently, almost 50% of world's food fish is supplied by aquaculture and also has the potential to substantially contribute to the food demand of the growing human population of the world. Punga fish is one of the major fish species in the Mekong River fisheries, one of the largest and most important in land fisheries in the world (Roberts and Vidthayanon, 1991). This species is widely exploited for cage culture in the Mekong Delta (Cacot, 1993). Floating cages are located on the river, mostly in southern Vietnam and close to the Cambodian border. About 2,000 cages produce 15,000 tons of *P. bocourti* per year. Breeding in captivity was first achieved in 1995 and artificial propagation was later obtained with brooders reared both in ponds and in floating cages (Cacot, 1999). The rearing period varies from 10 to 13 months to reach a commercial weight of 1 - 1.5 kg/fish in Vietnam. In Thailand, the market body weight depends on type of product processing, ranging from 500 - 1200 g/fish, and the price ranges from 50 to 150 Bath per kg. Carcass quality is defined as a combination of physical properties including percentage of lean meat, fat and bone and indicates a feature that affects the quantitative economic value. This is also a measure of the success for the manufacturer (Jaturasitha, 2007). The skeletal muscle (fillet) is the major part of the edible portion of fish. Unlike mammals and birds, whose skeletal muscles are arranged in very long bundles of fibers, the muscles of fish are shorter and arranged in muscle sheets which are termed myotomes or myomeres (Brown, 2001). Fillet yield is the ratio between fillet weight and carcass weight and is a measure of the proportion of the edible part of the body. Filleting implies removal of bones, fins and skin from the flesh. There are studies reporting that breed (Hopkins and Fogarty, 1998; Kremer et al., 2004), and also the type of feed (Jacques et al., 2011) can affect the characteristics of the carcass (weight, conformation, fat content etc.) and meat (pH, texture, color, and nutritional composition). Considering the large variation in market slaughter weights of Punga fish, the purpose of the present study was to investigate the effects of slaughter weight on carcass and meat quality. The data obtained will provide information about carcass and meat quality to be expected at different weights and thus enable farmers and consumers to choose the best weight for a distinct purpose, including that for export.

2. Materials and methods

2.1. Animals and experimental design

A total of 240 Punga fish, were cultured at Thai Panga Farm Co.Ltd, Kalasin province, Thailand, a commercial farm, and provided for this experiment. They were divided into three groups (80 fish/group) based on weight (700, 900 and 1200 g, respectively) reflecting the different preferences on the market (national and international). They were reared in three ponds according to the weight purpose.

2.2. Carcass quality measurement

All fish were fed daily a pelleted diet until market size was reached then fasted 24 h prior to slaughtering. They were caught from cultured ponds by netting. The fish were slaughtered at the same time when they reached the slaughter weight. They were immediately stunned in cold water and bled by a sharp knife. Then, live weight, total length, head length (HL) height (H) and width (W) were recorded (Sahu et al., 2000). Afterwards deheading, cutting off of tails and fins and removing viscera followed. The weights of hot carcass, viscera, head, tail, and fins as well as skinned weights were recorded. Afterwards, the carcasses were kept at 4 °C for 24 h by which time the fish had entered a rigor mortis state (Einen et al*.,* 1998). After recording cold carcass weight fish was dressed. Bones, skin, and fillets, separated into dorsal and ventral sections, were weighed and their proportion of carcass weight was calculated. Finally, the samples were stored in vacuum-packaged form at 4 °C and -20 °C for further analysis.

2.3. Meat quality measurement

The pH (pH meter model 191, Knick, Berlin, Germany) was determined in the fillets at 45 min and 24 h post-mortem. Chemical composition was determined by proximate analysis (AOAC, 1995), water-holding capacity (WHC) was assessed via substance losses occurring during different procedures (Jaturasitha, 2007). Collagen concentration was evaluated by the hydroxyproline method (Hill, 1966) and calculated from the absorbance standard curve of hydroxyproline. Lipid oxidation measurements were assessed by the 2 thiobarbituric acid (TBARS, thiobarbituric acid reactive substances) method (Rossell, 1994).

2.4. Statistical analysis

The data was analyzed considering the completed randomized design with three body weight treatments, 700 g (T1), 900 g (T2) and 1200 g (T3). When analyzing meat quality, the muscle sections (dorsal fillet and ventral fillet) and their interaction with slaughter weight were considered in addition in the analysis of variance (ANOVA). Multiple comparisons among means were carried out by Duncan’s new multiple range test. All data was analyzed by SAS (SAS, 2008).

3. Results and discussion

3.1. Carcass composition

Carcass size and weight characteristics increased which increasing slaughter weight as expected. In relation to slaughter weight, differences between groups were only found with proportions of head, visceral and skin, but not with fillet (Table 1). The condition factor (CF), defined as the ratio of the body weight (grams) and body length (cm) cubed, and is commonly used to measure the conformation of fish (Gjedrem, 2005). This trait was considered to be an important economic trait, suitable also for breeding purposes. The CF determines the percentage of flesh present on the fish body, and it coincides with a high fillet yield (Rørå et al., 2001). Fillet yield is the ratio between fillet and carcass weight and is a criterion for the edible part of the body. In the present study, fillet yield was not different, but the 1200 g group had a higher CF than the 900 and 600 g groups. Filleting implies removal of bones, fins and skin from the flesh. Filleting and trimming are important for logistics, economics, and addition of value along the marketing chain and for separation of edible part from the inedible ones. Filleting in fish can be done either by machine or by hand. Hand filleting is labor intensive and time consuming (Rørå et al. 2001). Therefore most large companies use machines for filleting. However, fillet yield depends on the species and on the structural anatomy of the fish. Fish with smaller heads and frames relative to their musculature gives a higher fillet yield than fish with larger heads and frames. The percentage of fillet for farmed species was found range from 40% to over 70% (Rørå et al., 2001). Punga fish is at the lower end of this range.

3.2. Meat quality

Fillet pH decreased from when measured at 45 min to measurements at 24 h from 6.68 to 5.98 and 6.66 to 5.97 in dorsal and ventral fillet sections, respectively (Table 2). Actually, living animals have a neutral pH of 7.0 to 7.2 in the muscle which decreases to 6.0 or below postmortem (Jaturasitha, 2007). In general, fish muscle contains a relatively low level of glycogen compared to mammals; thus far less lactic acid is generated after death. However, fasting and the amount of stress and exercise encountered before death can have an effect on the level of stored glycogen and consequently on the ultimate post mortem pH. As a rule, well-rested, well-fed fish contain more glycogen than exhausted fish (). In cod, the pH drops from 6.8 to an ultimate pH of 6.1 - 6.5. In the large mackerel, the final pH may be lower, with the ultimate rigor pH being as low as 5.8 - 6.0, the range where the Punga fish in the present study was ranged, too; in tuna and halibut it even gets as low as 5.4 - 5.6. In a study of Japanese loach

(Chiba et al., 1991), it was shown that only minutes of pre-capture stress resulted in a drop by 0.50 pH units measured 3 h postmortem as compared to non-struggling fish whose pH dropped only 0.10 units in the same period. Moreover, the same authors showed that bleeding of fish significantly reduced the post mortem lactic acid production. In the present study, the pH of every treatment was at a normal level. Still there was a greater drip loss in dorsal fillet of the 900 and 1200 g heavy groups compare to that weighing 700 g.

Table 1 Carcass quality of Punga fish (*Pangasius bocourti* Sauvage) as affected by slaughter weight

Trait	Slaughter weight			P Value	SEM
	700 g	900 g	1200 g		
Body weight (g)	689^{c}	891^{b}	1153^{a}	<0.001	0.052
Carcass weight (g)	432^{c}	560^{b}	731^{a}	<0.001	0.052
Cold carcass (%)	60.8	61.5	61.2	0.097	5.019
Size (cm)					
Head	10.7^{c}	11.8^{b}	13.1^{a}	<0.001	1.134
Tail	46.0^{c}	49.6^{b}	53.4^{a}	<0.001	1.626
Body	22.4^{c}	25.0^{b}	27.9^{a}	<0.001	1.297
Height	8.05^{c}	8.82^{b}	9.66^{a}	<0.001	0.472
Width	4.10^{c}	4.45^{b}	4.98^{a}	<0.001	0.215
Condition factor (CF)†	0.009^{c}	0.011^{b}	0.013^{a}	<0.001	0.001
Fillet yield (fillet-to-carcass weight ratio)	0.511	0.530	0.521	0.400	0.061
Head weight (%)	31.8^{b}	30.5^{a}	29.5^{a}	0.005	2.929
Visceral weight (%)	5.53^{b}	5.67^{b}	6.48^{a}	0.002	1.812
Skin weight (%)	4.10^{b}	4.16^{b}	4.67^{a}	0.037	0.952
Skeleton weight (%)	25.5	25.7	25.8	0.764	2.313
Fillet (%)	30.4	31.2	30.7	0.118	3.393
Dorsal muscle	17.6	17.9	17.6	0.101	2.118
Ventral muscle	12.9	13.2	12.7	0.294	1.700

†Ratio of the body weight (grams) and body length (cm)

^{a,b,c} Mean within the same row with different superscripts differ significantly (P<0.05).

Moisture and protein percentages of the fillets did not differ among groups. The highest fat percentage was found in the ventral section (1.62%, P<0.05). Moreover, fat percentage of the ventral section in the 1200 g group was highest (1.62%, P≤0.05) compared with the other groups. In the study of Thammapat et al. (2010), there was considerable variability in lipid content of different body tissues in catfish. Generally, viscera (93%) and the ventral portions (5 - 8%) had higher contents of lipid (and lower contents of protein and moisture) than the dorsal portion (3 - 6%), respectively. Lipid synthesis in the animal is increasing with age. Fat concentration can affect to water holding capacity of meat also. Free water in the muscle is packed in micelles. Water is a polar molecule inside and lipids are non-polar molecules outside. So, when more fat can be protected, there is more free water in the animal's muscle. For this reason, the 1200 g weighing group that was oldest and highest in fat concentration, might also have had the greatest drip loss. Protein content was also inversely proportional to the lipid content in all portions, cranial-dorsal and central-dorsal portions were found to have the highest protein content which was lowest in the viscera (P<0.05). The TBARS values increased in each group and meat sections during a period of storage of 3 days. The ventral section of the fillet of the 1200 g weighing group had the highest TBARS level (3.54, P<0.05). Generally, the contents of lipid and protein of cultured fish are dependent on genotype, exercise or movement of the fish muscle, and feeding. One of the most important causes of meat food deterioration is lipid oxidation, which affects fatty acids, particularly polyunsaturated fatty acids. This lipid auto oxidative degradation gives products that change the food quality, e.g. the color, aroma, flavor, texture and even the nutritional value (Gray, 1978; Allen and Allen, 1981). There were no obvious slaughter weight (age) effects on collagen traits.

Table 2 Meat quality of Punga fish (*Pangasius bocourti* Sauvage) as affected by slaughter weight and fillet section

Criteria	Slaughter weight			Muscle		SEM	Significance		
	700 g	900 g	1200 g	Dorsal	Ventral		Weight	Muscle	Treatment× muscle
pH_I	6.89^{a}	6.75^{b}	6.36^{c}	6.68	6.66	0.201	**	NS	NS
pH_U	6.10^{a}	6.05^{a}	5.78^{b}	5.98	5.97	0.202	**	NS	NS
Drip loss (%)	4.88^{a}	3.02^{b}	2.88^{b}	3.01^{b}	4.18^{a}	1.502	**	*	*
Thawing loss (%)	5.12	6.00	6.48	5.37	6.36	2.180	NS	NS	NS
Boiling loss (%)	7.02^{b}	9.24^{a}	10.66^{a}	8.93	9.01	2.321	**	NS	**
Chemical composition (%)									
Moisture	78.8	78.5	78.4	78.7	79.0	2.432	NS	NS	NS
Protein	21.1	20.9	20.1	21.3	20.7	2.810	NS	NS	NS
Fat	1.02^{c}	1.21^{b}	1.62^{a}	1.15^{b}	1.62^{a}	0.780	*	*	**
Collagen (%)									
Soluble collagen	2.45	2.58	2.46	2.23^{b}	2.76^{a}	0.771	NS	**	NS
Insoluble collagen	1.86	1.96	1.75	1.46^{b}	2.25^{a}	0.943	NS	**	**
Total collagen	4.31	4.55	4.22	3.70^{b}	5.02^{a}	1.355	NS	**	**
TBARS (mg/kg)									
Day0	0.24^{b}	0.37^{b}	0.85^{a}	0.40^{b}	0.68^{a}	0.122	**	*	NS
Day1	0.36^{b}	0.47^{b}	0. 98^{a}	0.52^{b}	0.98^{a}	0.251	**	*	NS
Day2	1.42^{b}	1.33^{b}	1.80^{a}	1.49^{b}	1.82^{a}	0.226	**	**	NS
Day3	2.60^{c}	3.15^{b}	3.54^{a}	2.69^{b}	3.31^{a}	0.818	**	**	NS
Day6	0.28^{c}	0.35^{b}	0.86^{a}	0.39^{b}	0.66^{a}	0.283	**	**	NS

^{a,b,,c}Means within a row with no common superscripts are significantly different (P < 0.05).
*, **Factors effects are significantly at P < 0.05 and 0.01, respectively.

4. Conclusion

The present study has shown that there are differences in carcass and meat quality among different slaughter weights and fillets of Punga fish but, when related to carcass weight, these differences were comparably small. Opposite to the 1200 g weighing group, the fillets of the light fish groups had the greatest water holding capacity and the lowest inclination for fat incorporation and susceptibility for oxidation. A low weight seems therefore preferable for high product quality.

Acknowledgements

The authors would like to express thanks to Thai Punga Farm Com, Ltd. for providing fish. The financial supported by National Research Council of Thailand and the National Research University under the commission of higher Education, Ministry of Education, Royal Thai Government. The authors are grateful to the staff of the processing and production development factory, The Royal Project Foundation and the Department of Animal and Aquatic Sciences, Faculty of Agriculture, Chiang Mai University for technical assistance during the experiments.

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